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(54) Title: BIODEGRADABLE HERBICIDAL COMPOSITION

(57) Abstract

Disclosed is a herbicidal composition and method for non-selectively controlling and retarding the growth rate, and if desired, causing extensive mortality of, unwanted vegetation. The compositions consist essentially of one or more substances selected from the group consisting of aliphatic acids or their herbicidally active salts, preferably octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, or dodecanoic acid, and an ammonium compound, preferably ammonium nitrate, sulfate, or sulfamate. The composition causes a plant mortality significantly in excess of the expected additive mortalities of the individual components.

f-acid + ammonium Comp.

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BIODEGRADABLE HERBICIDAL COMPOSITION

Background of the Invention

This invention relates to compounds and methods for non-selectively retarding and controlling the growth rate of unwanted vegetation using a family of environmentally safe herbicidal compositions. More particularly, it relates to the use of certain fatty acids or their salts in admixture with an ammonium compound to induce an immediate topical burn followed by a tap root kill preventing regrowth of unwanted vegetation. As used herein, the words "retarding and controlling" refer to partial or complete killing of vegetation.

Herbicides control the growth rate and/or cause mortality to flora through physiochemical interactions with plant systems. Many chemical classes of herbicides are presently available with varying modes of action, toxicities, chemical structures, and use patterns. Billions of dollars are spent annually to control vegetation pests which, due to importation or other causes, lack the natural enemies to keep their population in check, or which simply grow from seed in areas where they interfere with land use. Previously, inorganic compounds were used to control vegetation, but these have been superceded by effective petro-chemical products. Mass production of petro-chemical herbicides reduced the overall cost of vegetation control and facilitated widespread use.

Environmental safety has become a paramount concern due to increasing public awareness, shifting

attitudes towards better alternatives to pest control, and the accumulation of data on longer term environmental effects. Many of the petro-chemical herbicides are toxic to other forms of life and are environmentally persistent. Therefore, there remains a need for an environmentally safe, cost effective method for controlling unwanted vegetation.

Ammonium compounds have been used as fertilizers. Generally, they are used in a form, such as the salt form, which releases the ammonium ion upon decomposition. When used in sufficiently high concentrations, these ammonimum compounds are injurious to plants. Ammonium sulfamate has been used as a translocatable herbicide, and is registered in the United States as a herbicide by E.I. Du Pont de Nemours under the tradename Ammate. Ammonium sulfamate has little immediate effect on foliage, but eventually is absorbed into the plant causing cell damage and finally death. However, it must be used in very high concentrations to be effective.

Summary of the Invention

This invention provides novel herbicidal compositions which are environmentally safe, biogradable, effective, and cost efficient. Broadly, the invention comprises a family of compositions which may be applied to retard and control the growth of unwanted vegetation, and a method of using such compositions. The compositions comprise one or more substances taken from the family of organic fatty acids, preferably straight-chained alpha monocarboxylic acids comprising 6 to 18 carbon atoms inclusive, and/or salts of the aforementioned acids, in combination with one or more ammonium compounds, preferably ammonium nitrate, ammonium sulfate or ammonium sulfamate. It has been discovered that mixtures of these two groups of compounds can cause a synergistically enhanced plant mortality. That is, the components when mixed cooperate to give a significantly higher kill rate than the sum of the kill rates of the individual components in a broad range of ratios and on a broad range of plant species.

The fatty acids and inorganic ammonium compounds employed in these compositions are essentially non-toxic to vertebrates and are biodegradable. Of the hundreds of fatty acids found in nature, only a few possess herbicidal properties. These are found on human skin, in seeds, and as part of the total lipid composition of many organisms. Mammals metabolize and/or excrete these fatty acids, and many micro-organisms can utilize them as a source of carbon.

One important embodiment of the present invention comprises a herbicidally active composition consisting essentially of a 50:50 mixture of ammonium nonanoate and ammonium decanoate at a concentration of between 0.01% and 0.50%, admixed with a water soluble inorganic ammonium compound, preferably ammonium sulfamate, at a concentration between 0.50% and 5.00%. Species of this combination results in a synergistically enhanced kill against vegetation including relatively hardy species such as Phaseolus vulgaris (green bush plant), Hypocheris radicata (false dandelion), Tropaelum majus (nasturtiums) and Zea mays (corn).

In accordance with the process of the invention, the herbicidal mixtures are applied to the leaves or soil to retard plant growth, preferably in amounts sufficient to kill the plant.

Accordingly, it is an object of the invention to provide a class of herbicidal compounds composed of medium chain fatty acids and/or their salts and inorganic ammoniated compounds. Other objects are to provide a method for nonselectively controlling unwanted vegetation by applying compounds composed of medium chain fatty acids and/or their salts and inorganic ammoniated compounds to provide a class of herbicides which are environmentally safe, and to provide a class of non-selective herbicides utilizing commercially available, relatively inexpensive constituents.

Description

Fatty acids and their salts containing eight to twelve carbon atoms cause easily observed topical burn to plants when applied at concentrations of about 0.5% by weight or higher. However, these compounds do not translocate within the plant and can fail to kill the root, particularly when applied to tap root plants such as dandelions. Ammonium compounds, on the other hand, can translocate and kill tap roots, but have little immediate effect on foliage. It has been discovered that mixtures of the active fatty acids or salts with the ammoniated compounds provide a unique coaction, yielding higher kill rates and a surer kill, on a wide variety of plant types, particularly annuals and small perennials. The combination in ingredients provides a rapid topical kill as well as a delayed tap root kill, providing a far superior herbicide as compared with either compound alone. Mixtures of these two types of compounds when applied to roots or foliage can provide greater mortality effects than the sum of the effects of the individual components.

Within the fatty acid group, acids posessing nine or ten carbon atoms have been observed to perform best. They are particularly advantageous because they are relatively inexpensive and readily available. Acids having eight, eleven, and twelve carbon atoms are almost as effective as the acids having nine or ten carbon atoms. Fatty acids having a carbon number smaller than eight, e.g., six or seven, and larger than 12, e.g., 13 to 18, are usable although less effective. Mixtures of the acids in

this group also perform well as components in the composition of the invention. These fatty acids may be in the pre-acid form or in herbicidally acceptable salt forms. These salts can include, for example, ammonium, alkali metal, or alkali earth metal salts. Alkali metal salts such as the sodium or potassium salt and ammonium salts are preferred. The acids are available commercially. They may be neutralized with bases of various types. The acids used in the experiments below were obtained from Emery Company.

The preferred ammonium compounds are inorganic ammonium compound which, when applied at appropriate concentrations, causes damage to plants. Preferred among ammonium compounds are herbicidally active inorganic, water-soluble ammonium salts. Ammonium sulfamate is currently most preferred because it is the strongest herbicide among the ammonium compounds. Ammonium sulfate and ammonium nitrate are also preferred. Other ammonium compounds which may be used include ammonium chloride, ammonium carbonate and ammonium acetate. Others will be readily apparent to those skilled in the art.

The ratio of the fatty acid or its salt to the ammonium compound may vary widely, depending upon a variety of factors, such as the identity of the fatty acid or its salt, the identity of the ammonium compound, the composition formed, the target weed, and whether the composition is intended as a concentrate or is to be applied as is. Generally, the ratio of acid compound to ammonium compound is between 0.001 and 10, preferably between 0.01 and 1.0, more preferably between 0.02 and 1.0.

The amount of the essential components in the composition may also vary. Normally the total amount is at least 0.1% by weight. Preferably, the total amount of the ammonium compound and the fatty acid or its salt is at least 0.5% by weight, more preferably at least about 1% by weight. Neither of the essential active ingredients have very strong herbicidal activity, and accordingly, the total amount of active ingredients used is relatively high compared with petrochemical herbicides. However, both components are environmentally safe and inexpensive. The upper limit of the amount of activity in the composition may be determined by taking various factors into account, including whether the composition is intended as a concentrate or a ready-to-use product, what carrier or diluent is to be used, solubility considerations, and the composition's intended mode of application.

The herbicidal compositions embodying the invention may be applied in various ways, including topically as a spray to foliage as a post-emergence herbicide, and also as a pre-emergence herbicide if formulated appropriately, for example, sorbed in powder or granules. When applied as a post-emergence herbicide, an aqueous solution or emulsion form is best for a ready-to-use formulation. Seedling weeds are the easiest to control, as is typical of most herbicidal compositions. Many annuals may be controlled with a single application. Established weeds with large tap roots may require additional treatments.

Compositions of the invention typically are water based, and may include ingredients in addition to the two or more active components noted above such as stabilizers and solubility enhancing materials.

Experiments have been conducted in nursery and field conditions on growing seedlings and established vegetation. Results indicate that vegetation is non-selectively and effectively killed by the methods and compositions of the invention. The following, non-limiting examples demonstrate the unexpected properties of compositions embodying the invention, and illustrate the generality of those unexpected properties.

False dandelion (Hypochoeris radicate), crab grass (Agropyron repens) and yellow foxtail (Setaria glauca) were tested in the following experiments as model target weeds. The other plants tested, nasturtiums (Tropaeolum majus), bush beans (Phaseolus vulgaris), corn (Zea mays), and cucumber (Cucumis satirus) represent flora of varying cuticle thickness and morphology. In this specification, all percentages are by weight.

EXAMPLE 1

80 green bush plants, Phaseolus vulgaris, were randomly selected and labelled into 16 treatments with 5 replicates per treatment. The beans were grown in 5.5 cm pots with standard greenhouse soil mix. Plants were healthy and averaged 20.0 cm in height.

Treatment solutions were prepared from original chemicals. The compositions consisted of

ammonium nitrate (AN) at 1.0, 2.0, and 3.0% alone and in combination with a 50:50 mixture of ammonium nonanoate and ammonium decanoate (HS) applied at 1.0, 2.0, and 3.0%.

The procedure for the preparation of 100 grams of the test herbicides is:

a. Weigh appropriate quantity of fatty acid or mixture into beaker.

b. Into another beaker weigh 90.00 gram deionized H_2O.

c. Add appropriate amount of ammonium salt to water.

d. Stir water and ammonium salt and slowly add fatty acid or acid mixture.

e. While stirring, add ammonium hydroxide (or other base) dropwise until solution clears.

f. Add deionized H_2O until weight equals 100 grams.

The pH of the resulting solution typically is slightly alkaline. The pH of the C9/C10-ammonium nitrate mixtures used in this example was about 8.0.

Treatment involved application of a thin coating of the test solutions by paintbrush to the large true leaves of the beans. Assessment was performed 8 days later by visually rating damage of foliar area using a pretransformed angular scale (0-10) where integers represent 0, 2.5, 10, 21, 35, 50, 65, 79, 90, 97.5, and 100% foliar damage. The Table below summarizes the compositions of the test solutions.

Table 1:

Treatment Number	Comp. %HS	Comp. %AN	Treatment Number	Comp. %HS	Comp. %AN
1	0	0	9	2	0
2	0	1	10	2	1
3	0	2	11	2	2
4	0	3	12	2	3
5	1	0	13	3	0
6	1	1	14	3	1
7	1	2	15	3	2
8	1	3	16	3	3

AN = ammonium nitrate
HS = fatty acid salts

Analysis of variance showed a significant effect from treatment (F = 77.36 where Fc = 2.06 at 15, 64 degrees of freedom). Separation of treatment means was performed with Duncan's multiple range test. The results are set forth in Table 2.

Table 2:

Concentration of AN	Concentration of HS			
	0%	1%	2%	3%
0%	0%	44.0%	100%	100%
1%	2.0%	100%	100%	100%
2%	37.0%	100%	100%	100%
3%	77.0%	100%	100%	100%

Ammonium nitrate (AN) at 1.0% in combination with the fatty acid salts (HS) at 1.0% (44.0% damage) produced an observed treatment effect of 100.0% damage, significantly greater than the expected

additive treatment effect of 46.0%. Similarly, ammonium nitrate at 2.0% (37.0% damage) in combination with HS at 1.0% (44.0% damage) produced the observed treatment effect of 100.0%, significantly greater than the expected additive treatment effect of 81.0%. At these ratios of active ingredients, the compounds act synergistically in efficacy in their kill of bush beans (Phaseolus vulgaris).

Example 2

160 false dandelion, Hypocheris radicata, plants were watered, selected and arranged into 20 treatments (8 replicates per treatment). Plants were of the same age and as uniform in growth development as possible (8-14 true leaves). Seedlings were grown in 3.5 centimeter diameter plastic vials with standard greenhouse soil mix. Plants were healthy, actively growing, and randomly placed into treatments.

Treatment solutions were prepared from original components in this and all subsequent examples disclosed herein using the procedure disclosed in Example 1, and 500 ml of each were bottled and labelled. The compositions consisted of ammonium sulfamate (AMS) applied at 0.5, 1.0 and 2.0%, alone, and in combination with a 50:50 mixture of ammonium nonanoate and ammonium decanoate (HS) at 0.01, 0.05, 0.1, and 0.25%. The test solutions were applied by hand-held trigger sprayer to run off, and the treated plants remained under artificial lights for assessment. Assessment was performed three days from treatment. In this and all subsequent examples

disclosed herein, the pretransformed angular scale (0-10) as disclosed in Example 1 was used for visual damage assessment. The various mixtures used are set forth below.

Table 3:

Treatment Number	Comp. %HS	Comp. %AMS	Treatment Number	Comp. %HS	Comp. %AMS
1	0	0	11	0.05	1.00
2	0	0.50	12	0.05	2.00
3	0	1.00	13	0.10	0
4	0	2.00	14	0.10	0.50
5	0.01	0	15	0.10	1.00
6	0.01	0.50	16	0.10	2.00
7	0.01	1.00	17	0.25	0
8	0.01	2.00	18	0.25	0.50
9	0.05	0	19	0.25	1.00
10	0.05	0.50	20	0.25	2.00

The data were analyzed statistically using ANOVA and Duncan's multiple range test to separate treatment means. The results were as follows.

Table 4:

Concentration of AMS	Concentration of HS				
	0%	0.01%	0.05%	0.10%	0.25%
0%	0.0%	0.0%	5.0%	24.0%	98.0%
0.5%	15.0%	8.0%	50.0%	79.0%	99.0%
1.0%	29.0%	22.0%	67.0%	94.0%	100.0%
2.0%	85.0%	66.0%	96.0%	99.0%	100.0%

Statistical analysis showed a significant effect due to treatment, F = 68.90 where Fc = 1.83 at 19, 140 degrees of freedom (P = 0.05). HS at 0.05% and 0.10% active ingredient combined with ammonium sulfamate at 0.5% and 1.0% active ingredient interacted synergistically to produce statistically greater mortality to *Hypochoeris radicata* plants than either herbicide applied individually. The synergy at higher concentrations results in 100% kill.

Example 3

120 *Tropaeolum majus* plants (nasturtiums) were watered, selected, and arranged into 20 treatments (6 replicates per treatment), and tested as set forth in Example 2. The compositions of the test mixtures are set forth in Table 5.

Table 5:

Treatment Number	Comp. %HS	Comp. %AMS	Treatment Number	Comp. %HS	Comp. %AMS
1	0	0	11	0.05	1.00
2	0	0.50	12	0.05	2.00
3	0	1.00	13	0.10	0
4	0	2.00	14	0.10	0.50
5	0.01	0	15	0.10	1.00
6	0.01	0.50	16	0.10	2.00
7	0.01	1.00	17	0.25	0
8	0.01	2.00	18	0.25	0.50
9	0.05	0	19	0.25	1.00
10	0.05	0.50	20	0.25	2.00

The data were analyzed statistically using

ANOVA and Duncan's Multiple Range Test to separate treatment means. The results were as follows:

Table 6:

Concentration of AMS	Concentration of HS				
	0%	0.01%	0.05%	0.10%	0.25%
0%	0.0%	0.0%	0.0%	32.0%	47.0%
0.5%	0.0%	1.0%	23.0%	70.0%	85.0%
1.0%	7.0%	1.0%	25.0%	75.0%	93.0%
2.0%	2.0%	4.0%	53.0%	79.0%	95.0%

Statistical analysis showed a significant effect due to treatment, F = 55.60 or Fc = 1.87 at 19, 100 degrees of freedom (P = 0.05). HS at 0.05%, 0.10% and 0.25% combined with AMS at 0.5%, 1.0% and 2.0% active ingredient, interacted synergistically to produce statistically greater efficacy to nasturtiums than either compound applied individually.

Example 4

160 Zea mays, corn, plants were watered, selected and arranged into 20 treatments (8 replicates per treatment). Plants were of the same age and as uniform in growth development as possible. Seedlings were grown in 3.5 centimeter diameter vials with standard greenhouse soil mix. Plants were healthy, actively growing, averaging 18.0 centimeters in height, and were randomly placed into treatments.

The compositions consisted of ammonium sulfamate (AMS) applied at 0.5, 1.0 and 2.0%, alone and in combination with HS at 0.01, 0.05, 0.1, and 0.25%. The compositions were applied by hand-held

trigger sprayer to run off, and the treated plants remained under artificial light for assessment. Assessment was performed five days after treatment using the pretransformed angular scale. The test mixtures are set forth below.

Table 7:

Treatment Number	Comp. %HS	%AMS	Treatment Number	Comp. %HS	%AMS
1	0	0	11	0.05	1.00
2	0	0.50	12	0.05	2.00
3	0	1.00	13	0.10	0
4	0	2.00	14	0.10	0.50
5	0.01	0	15	0.10	1.00
6	0.01	0.50	16	0.10	2.00
7	0.01	1.00	17	0.25	0
8	0.01	2.00	18	0.25	0.50
9	0.05	0	19	0.25	1.00
10	0.05	0.50	20	0.25	2.00

The data were analyzed statistically using ANOVA and Duncan's Multiple Range Test to separate treatment means. The results were as follows:

Table 8:

Concentration of AMS	Concentration of HS 0%	0.01%	0.05%	0.10%	0.25%
0%	0.0%	1.0%	6.0%	16.0%	22.0%
0.5%	0.0%	0.0%	16.0%	27.0%	63.0%
1.0%	1.0%	1.0%	24.0%	27.0%	55.0%
2.0%	2.0%	13.0%	34.0%	32.0%	88.0%

Statistical analysis showed a significant effect due to treatment, F = 25.66 where Fc = 1.83 at 19, 140

degrees of freedom (P = 0.05). Combinations of HS and ammonium sulfamate were shown to act synergistically in killing corn plants.

Example 5

96 *Phaseolus vulgaris* bean plants were watered, selected and arranged into 12 treatments (8 replicates per treatment). Plants were of the same age and as uniform in growth development as possible. Seedlings were grown in 5.5 centimeter square pots with standard greenhouse soil mix. Plants were healthy, actively growing, averaging 24.0 centimeters in height, and randomly placed into treatment.

The compositions consisted of AMS applied at 0.5, 1.0 and 2.0%, alone and in combination with HS at 0.25%. The compositions were applied by hand-held trigger sprayer to run off, and the plants remained under artificial light for assessment. Assessment was performed four days from treatment using the pretransformed angular scale.

Table 9:

Treatment	Comp.		Treatment	Comp.	
Number	%HS	%AMS	Number	%HS	%AMS
1	0	0	5	0.25	0
2	0	0.50	6	0.25	0.50
3	0	1.00	7	0.25	1.00
4	0	2.00	8	0.25	2.00

The data were analyzed statistically using ANOVA and Duncan's multiple range test to separate treatment means. The results were as follows:

Table 10:

Concentration of AMS	Concentration of HS	
	0%	0.25%
0%	0.0%	13.0%
0.5%	6.0%	21.0%
1.0%	21.0%	42.0%
2.0%	52.0%	89.0%

Example 6

112 crab grass, *Digitaria sanguinalis*, plants were watered, selected and arranged into 16 treatments (7 replicates per treatment). Plants were of the same age and as uniform in growth development as possible. Seedlings were grown in 3.5 centimeter diameter vials with standard greenhouse soil mix. Plants were healthy, actively growing averaging 15.0 centimeters in height, and were randomly placed into treatment.

The compositions consisted of AMS applied at 0.5, 1.0 and 2.0%, alone and in combination with HS at 0.01, 0.05, 0.1 and 0.25%. The compositions were applied by hand-held trigger sprayer to run off, and the plants were left under artificial lights for assessment. Assessment was performed five days from treatment using the pretransformed angular scale. Test compositions are noted below.

Table 11:

Treatment Number	Composition %HS	%AMS	Treatment Number	Composition %HS	%HMS
1	0	0	9	0.10	0
2	0	0.50	10	0.10	0.50
3	0	1.00	11	0.10	1.00
4	0	2.00	12	0.10	2.00
5	0.05	0	13	0.25	0
6	0.05	0.50	14	0.25	0.50
7	0.05	1.00	15	0.25	1.00
8	0.05	2.00	16	0.25	2.00

The data were analyzed statistically using ANOVA and Duncan's multiple range test to separate treatment means. The results are set forth below:

Table 12:

Concentration of AMS	Concentration of HS			
	0%	0.05%	0.10%	0.25%
0	0.0%	15.0%	13.0%	63.0%
0.5%	1.0%	36.0%	36.0%	79.0%
1.0%	8.0%	24.0%	58.0%	92.0%
2.0%	15.0%	79.0%	77.0%	99.0%

Statistical analysis showed a significant effect due to treatment, F = 58.64 where Fc = 1.98 at 15, 90 degrees of freedom (p = 0.05). HS combined with ammonium sulfamate produced greater herbicidal efficacy to <u>Digitarias sanguinelis</u> plants than either herbicide applied individually.

Example 7

120 nasturtium Tropaeolum majus, plants, were randomly selected and labelled into twelve treatments with 10 replicates per treatment. Nasturtium were grown in 3.5 cm diameter vials with standard greenhouse soil mix. Plants were healthy, actively growing and averaged 11.0 cm in height.

The compositions consisted of ammonium sulphate (AS) at 1.0, 3.0 and 5.0%, alone and in combination with HS applied at 0.10 and 0.20% active ingredient. The compositions were applied by hand-held trigger sprayer to run off. Assessment was performed three days later using the pretransformed angular scale.

Table 13:

Treatment Number	Comp. %HS	Comp. %AS	Treatment Number	Comp. %HS	Comp. %AS
1	0	0	7	0.10	3.0
2	0	1.0	8	0.10	5.0
3	0	3.0	9	0.20	0
4	0	5.0	10	0.20	1.0
5	0.10	0	11	0.20	3.0
6	0.10	1.0	12	0.20	5.0

The data were analyzed statistically using ANOVA and Duncan's multiple range test to separate treatment means. The results are set forth below:

Table 14:

Concentration of AS	Concentration of HS		
	0%	0.10%	0.20%
0%	0.0%	19.0%	54.0%
1.0%	0.0%	51.0%	93.0%
3.0%	0.0%	40.0%	95.0%
5.0%	0.0%	43.0%	99.0%

Statistical analysis showed a significant effect due to treatment $F = 61.78$ ($p = 0.05$). Combinations of HS and ammonium sulphate thus act synergistically in rate if mortality when applied to nasturtiums.

Example 8

120 cucumber, Cucumis sativus, plants, were randomly selected and labelled into twelve treatments with 10 replicates per treatment. The plants were healthy, actively growing, and averaged 10.0 cm in height.

The compositions consisted of AS at 1.0, 3.0 and 5.0%, alone and in combination with HS applied at 0.10 and 0.20% active ingredient. The compositions were applied by hand-held trigger sprayer to run off. Assessment was performed two days later using the pretransformed angular scale.

Table 15:

Treatment Number	Comp. %HS	%HS	Treatment Number	Comp. %HS	%AS
1	0	0	7	0.10	3.0
2	0	1.0	8	0.10	5.0
3	0	3.0	9	0.20	0
4	0	5.0	10	0.20	1.0
5	0.10	0	11	0.20	3.0
6	0.10	1.0	12	0.20	5.0

The data were analyzed statistically using ANOVA and Duncan's multiple range test to separate treatment means. The results are set forth below:

Table 16:

Concentration of AS	Concentration of HS		
	0%	0.10%	0.20%
0%	0.0%	9.0%	19.0%
1.0%	0.0%	12.0%	15.0%
3.0%	2.0%	12.0%	39.0%
5.0%	11.0%	33.0%	81.0%

Statistical analysis showed a significant effect due to treatment, F = 27.36 (P = 0.05). Combinations of HS and ammonium sulphate were shown to act synergistically in herbicidal activity when applied to <u>Cucumus sativus</u> plants.

<u>Example 9</u>

120 yellow foxtail <u>Setaria glauca</u>, plants were randomly selected and labelled into twelve treatments with 10 replicates per treatment.

Foxtails were grown in 3.5 cm diameter vials with standard greenhouse soil mix. Plants were healthy, actively growing and averaged 14.0 cm in height. The compositions consisted of AS at 1.0, 3.0, and 5.0% alone and in combination with HS applied at 0.10% and 0.20%, active ingredient The compositions were applied by hand-held trigger sprayer to run off. Assessment was performed seven days later using the pretransformed angular scale.

Table 17:

Treatment Number	Comp. %HS	Comp. %HS	Treatment Number	Comp. %HS	Comp. %AS
1	0	0	7	0.10	3.0
2	0	1.0	8	0.10	5.0
3	0	3.0	9	0.20	0
4	0	5.0	10	0.20	1.0
5	0.10	0	11	0.20	3.0
6	0.10	1.0	12	0.20	5.0

The data were analyzed statistically using ANOVA and Duncan's multiple range test to separate treatment means. The results are set forth below:

Table 18:

Concentration of AS	Concentration of HS		
	0%	0.10%	0.20%
0%	0.0%	4.0%	18.0%
1.0%	0.0%	4.0%	13.0%
3.0%	1.0%	8.0%	27.0%
5.0%	7.0%	39.0%	46.0%

Statistical analysis showed a significant effect due to treatment, F = 23.75 (P = 0.05). Combinations of HS and AS were shown to act synergistically in efficacy to nasturtiums.

The invention may be embodied in other specific forms without departing from the spirit and essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A herbicidal composition for controlling unwanted vegetation, the composition comprising a herbicidally effective amount of a mixture of at least one herbicidally active alpha monocarboxylic acid having a hydrocarbon chain between 8 and 12 carbon atoms, salts thereof, and mixtures thereof, and at least one inorganic water soluble ammonium compound.

2. The composition of claim 1 wherein the ammonium compound is ammonium nitrate, ammonium sulfate, or ammonium sulfamate.

3. The composition of claim 1 wherein the acid component is nonanoic acid, decanoic acid, a salt thereof, or a mixture thereof.

4. The composition of claim 1 comprising an aqueous solution containing at least about one percent by weight of said mixture.

5. The composition of claim 1 wherein the ratio of said acid component to ammonium compound is withing the range of 0.001 to 10.

6. The composition of claim 1 wherein the ratio of said acid component to ammonium compound is with the range of 0.01 to 1.0.

7. The composition of claim 1 wherein said acid component comprises a mixture of the salts of decanoic and nonanoic acids.

8. The composition of claim 7 comprising ammonium sulfamate.

9. A method of controlling unwanted vegetation comprising applying to a plant having leaves and a root an amount of the composition of claim 1 effective to retard the growth rate of the plant.

10. The method of claim 9 wherein said composition is applied to the leaves of said plant.

11. The method of claim 9 comprising applying an amount of said composition effective to kill the root of said plant.

AMENDED CLAIMS

[received by the International Bureau on 20 March 1989 (20.03.89) original claims 2,5 and 6 cancelled; claims 1,3,7 and 9 amended; claims 4,8,10 and 11 unchanged; new claim 12 added (2 pages)]

1. (Amended) A herbicidal composition for retarding growth of vegetation, the composition comprising a herbicidally effective amount of an aqueous mixture comprising:

at least one first component selected from the group consisting of herbicidally active alpha, monocarboxylic organic acids having a hydrocarbon chain between 8 and 11 carbon atoms, salts thereof, and mixtures thereof, and

at least one ammonium compound selected from the group consisting of ammonium sulfate, ammonium sulfamate, and ammonium nitrate, the ammonium compound being present between about 1 and 200 parts by weight per part by weight said first component.

2. (Cancelled).

3. (Amended) The composition of claim 1 wherein the first component is selected from the group consisting of nonanoic acid, decanoic acid, salts thereof, and mixtures thereof.

4. The composition of claim 1 comprising an aqueous solution containing at least about one percent by weight of said mixture.

5. (Cancelled).

6. (Cancelled).

7. (Amended) The composition of claim 1 wherein said first component comprises a mixture of the salts of decanoic and nonanoic acids.

8. The composition of claim 7 comprising ammonium sulfamate.

9. (Amended) A method of controlling vegetation comprising applying to a plant having leaves and a root an amount of the composition of claim 1 effective to retard the growth rate of the plant.

10. The method of claim 9 wherein said composition is applied to the leaves of said plant.

11. The method of claim 9 comprising applying an amount of said composition effective to kill the root of said plant.

12. (New) The composition of claim 1 wherein said mixture is characterized by a herbicidal effectiveness greater than the sum of the herbicidal effectiveness of the first component and the ammonium compound.

STATEMENT UNDER ARTICLE 19

The foregoing Claims have been amended to more clearly and accurately describe the subject matter of the invention. Claims 2, 5 and 6 have been cancelled, and the subject matter has been incorporated into amended Claim 1. Support for new Claim 12 can be found in the application on page 3, lines 14-20, page 4, lines 8-13, and in Examples 1-9 on pages 8-23. Support for the remaining amendments can be found throughout the Claims and the Application as filed.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 88/03582

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC4: A 01 N 37/00, 59/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC4	A 01 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	GB, A, 1 243 987 (ESSO RESEARCH AND ENGINEERING COMPANY) 25 August 1971, see claim 1, page 3, lines 7-38 --	1,3,4,7, 9-11
Y	DE, A, 1 792 119 (UNILEVER-EMERY N.V.) 13 January 1972, see claim 13 --	1,3,4,7, 9-11
Y	US, A, 2 277 744 (MARTIN E. CUPERY ET AL.) 31 March 1942, see claims 3 and 5 --	1,2,8-11
Y	Chemie der Pflanzenschutz- und Schädlingsbekämpfungsmittel, Vol. 5, 1977 (New York) R. Wegler: "Herbizide ", see page 48, 4.3. b) --	1,2,9-11

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26th January 1989	13 FEB 1989
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN